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HALF A CENTURY OF RESEARCH - FORT VALLEY EXPERIMENTAL FOREST

1908 - 1958

ROCKY MOUNTAIN FOREST AND RANGE EXPERIMENT STATION
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FOREST SERVICE, U. S. DEPARTMENT OF AGRICULTURE


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REFLECTIONS

It was a sultry afternoon in August 1908. Raphael Zon, then chief of Silvics in the Forest Service, had come to Flagstaff to select a location for what was to be the first forest experiment station in the United States. Zon, Willard Drake, and I were urging our phlegmatic livery stable cayuses over the road to Fort Valley to examine a site that had been recommended by Frank Pooler, supervisor of the Coconino. Two miles short of our destination a thunderstorm crashed upon us in true Arizona style. The downpour was more violent than usual, so we took shelter in a large barn of the old A-1 Cattle Company. When we emerged an hour later, the normally dry Rio de Flag was running a hundred yards wide with a fluid whose color and consistency told plainly that the country was going to the dogs even in that early day. After crossing the "river", it was only half a mile to the area we had come to see -- a beautiful stand of ponderosa pine. "Here," said Zon, "we shall plant the tree of research."

--- G. A. Pearson
April 1936

HALF A CENTURY OF RESEARCH —

FORT VALLEY EXPERIMENTAL FOREST

1908 — 1958

by

Edward M. Gaines and Elmer W. Shaw[1]

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Fifty years ago in 1908, the U. S. Forest Service launched its research program in forest management on the Fort Valley Experimental Forest near Flagstaff, Arizona. This was the first scientific venture of its kind in America -- now the oldest.

From the beginning the chief aim of research here has been to work out better ways of managing ponderosa pine in the Southwest. Already, we have learned much. But to keep pace with the advance of science and industry, we need to know more. For example, in 1953 the pulp industry came to Flagstaff, bringing new opportunities for more intensive forest management. In the broader picture, recent forecasts presented in "Timber Resources for America's Future" indicate that the Nation will need all the wood we can grow. To help meet this rising demand, we must intensify our research and improve our management practices.

The historical background of Fort Valley, highlights of the research results, and the current program are presented in this Golden Anniversary publication.

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FACTS ABOUT FORT VALLEY

Location. --Headquarters for the Fort Valley Experimental Forest is right in the thick of the ponderosa pine about 9 miles northwest of Flagstaff. Locations of the 5 units of the forest are shown in figure 1.

Area. --4,700 acres.

Elevation. -- 6,700 to 8,000 feet.

Forest type. --Pure ponderosa pine. The experimental forest is located within the most extensive pure stand in the United States.

Climate. -- Cool and rather dry but favorable for tree growth. Annual precipitation averages 23 inches. Mean annual temperature is 43°F. In summer, temperatures usually reach 90°; in the average winter, they drop to 15° below zero.

Physical environment. --Topography is nearly level to rolling. Soils are mostly residual, very stony, sandy loams. Some soils have high cinder content. Geologically, the area contains tertiary volcanics (basalts, cinders, and other materials).

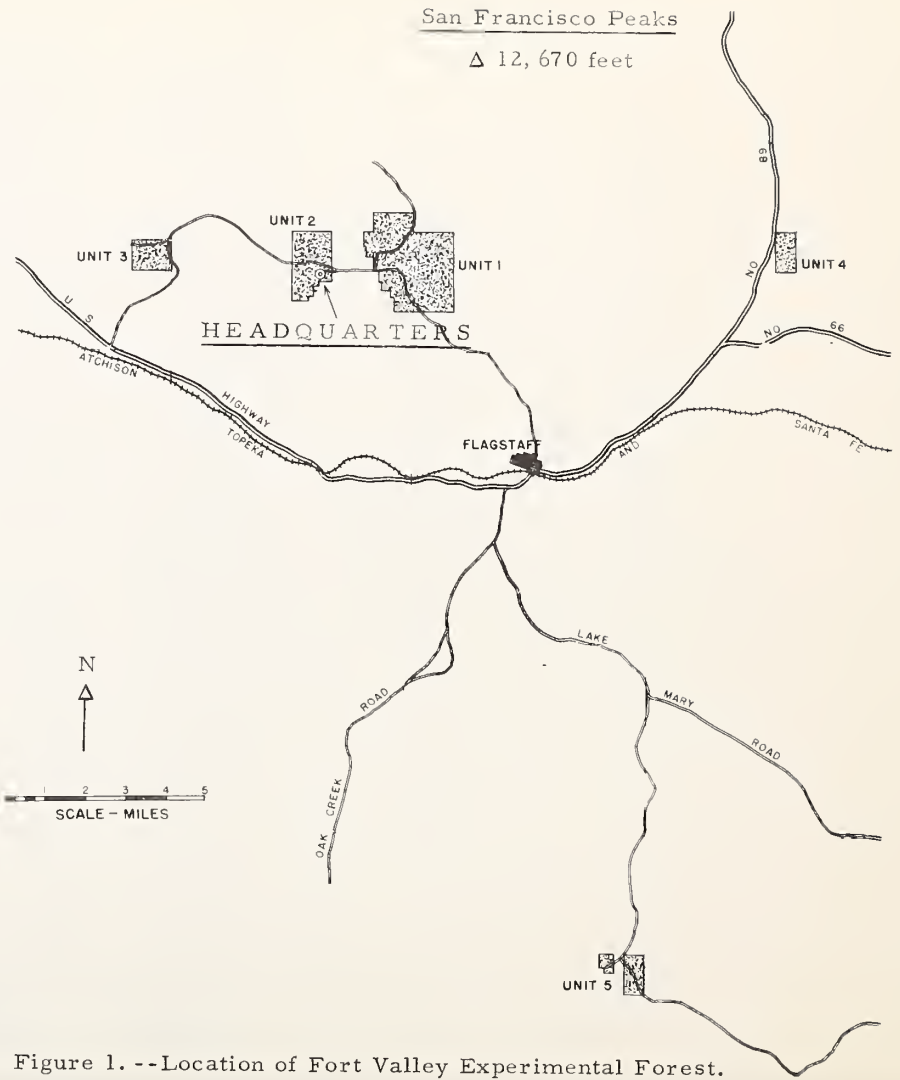

Figure 1. --Location of Fort Valley Experimental Forest.

PERSONNEL AND HISTORY

The name of G. A. "Gus" Pearson is indelibly stamped on forest management research at the Fort Valley Experimental Forest. Pearson started the work in 1908 and guided it until his retirement in 1945. Up to his death January 31, 1949, he continued working on his now-famous monograph, "Management of Ponderosa Pine in the Southwest."

Yet Pearson was the first to acknowledge the contribution of many associates who helped at one time or another to carry on the research program at Fort Valley. The list includes many who would be prominent in a "Who's Who" in American forestry. Raphael Zon and S. T. Dana, chief and assistant chief of silvical investigations in the Forest Service, and T. S. Woolsey, Jr., assistant regional forester (timber management) in Region 3, took active parts in early planning. Others who have participated actively in the work, more or less in chronological order, include:

Harrison D. Burrall
J. S. Boyce
Max H. Foerster
Harold H. Greenamyre
Alexander J. Jaenicke
Norman W. Scherer
Enoch W. Nelson
Clarence F. Korstian
Hermann Krauch
Harold S. Betts
S. S. Van Boskirk
Joseph C. Kircher
Emanuel Fritz
Lenthall Wyman
Ferdinand W. Haasis
Bert Lexen
E. M. Hornibrook
Elbert H. Little
Edward C. Martin
Frank W. Wadsworth
Geraldine Peterson
George S. Meagher
Francis R. Herman
Edward M. Gaines
M. M. Larson
L. P. Heidmann

This list may not be complete; early records are not always clear as to who worked in various capacities. Nor is the record clear as to the contributions made by Forest Service Region 3 personnel. Most of the assistant regional foresters in timber management have been helpful, as have been Coconino National Forest supervisors and many of their staffmen and rangers.

The forest was first called the "Coconino Experiment Station," then in 1911 was renamed the Fort Valley "Experiment Station." In the years following, a distinction developed between the "Experiment Station" -- the group of men conducting research and the "Experimental Forest"-- the area on which part of the research was done. In 1927, forest and range research throughout the Southwest was consolidated administratively as the Southwestern Forest and Range Experiment Station, with Fort Valley as a branch station. Pearson was director of the new station from its beginning until 1935, when he gave up the position in order to devote all his time to ponderosa pine research. General supervision and direction of research at Fort Valley has rested with subsequent directors of the Southwestern Station: Arthur Upson (1935-42) and Raymond Price (1942-53). The Southwestern Station was combined with the Rocky Mountain Forest and Range Experiment Station in 1953, and Price has continued as director of the enlarged Rocky Mountain Station.

The present research program at Fort Valley is conducted by Rocky Mountain Station personnel stationed on the campus of Arizona State College at Flagstaff.

As this history shows, an impressive roster of foresters have worked at Fort Valley over the years. Several have come and gone in rapid succession. Lack of funds, equipment, and personnel has always limited the Fort Valley research program. But in spite of these limitations, a great deal has been accomplished and much has been learned about ponderosa pine silviculture and management.

THE RESEARCH PICTURE

The accumulated results of 50 years of forest research at Fort Valley are too numerous to include here in any detail. Most of these findings have been summarized in Pearson's monograph: "Management of Ponderosa Pine in the Southwest."

Ecology and Silvics

Many of the silvical characteristics of southwestern ponderosa pine have been partially worked out at Fort Valley. For example, it has been found that:

1. Occurrence of ponderosa pine is limited by rainfall at lower elevations but by temperature at higher altitudes.

2. In virgin stands, ponderosa pine tends to grow in small, even-aged groups.

3. Ponderosa pine is not exacting in its soil requirements, but it makes best growth on soils whose physical properties provide the best moisture conditions.

4. Summer rain is important for germination and survival of seedlings, but soil moisture from winter storms sustains growth of older trees.

5. Sunlight influences growth; best tree form is developed in partial side shade (fig. 2). Moisture is important in determining total growth, especially as trees grow older and larger.

6. Growth of an individual immature tree is determined more by its position relative to competing trees than by its apparent vigor class. Immature trees of all vigor classes respond well to release from competition.

7. Height growth is practically complete by mid-July each year. Diameter growth usually continues through August (depending on summer rains) and needles continue growth into early fall.

8. Mature trees in virgin stands are mostly less than 300 years old.

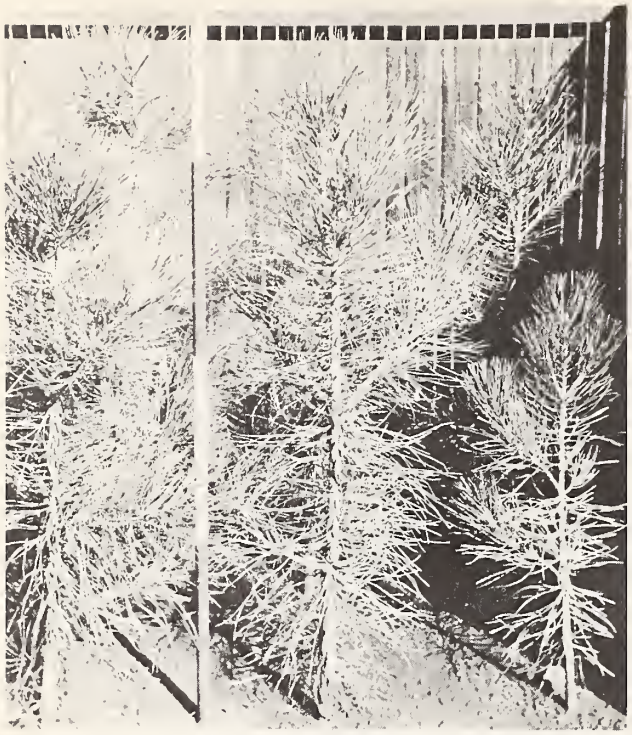

Figure 2.--A study of shade effects on ponderosa pine seedlings showed that partial side shade helps the plant develop a better form. Full sunlight tends to produce broad crowns, coarse branches, and thick, sharply tapering boles.

Much of the knowledge of silvics and ecology comes from incidental observations and data from studies in applied silviculture. More detailed understanding of principles of silvics and ecology will be needed for intensified management.

Regeneration

Lack of advance reproduction in 1908 was the main reason for beginning research at Fort Valley. Although much has been learned since then, techniques for insuring adequate regenerations at regular intervals are still unavailable.

Only once since 1908 has a really good stand of natural reproduction been established. That was in 1919 (fig. 3). All the basic requirements for natural regeneration were met that year: (1) a bumper seed crop the fall before; (2) favorable weather (especially rainfall) for early germination and survival; (3) favorable seedbed and limited competition from grass and weeds, resulting from heavy grazing in preceding years.

Figure 3. --Above, View of Fort Valley headquarters in 1916. Note the open parklike stand of ponderosa pine.
Below, The same view 26 years later. Natural regeneration almost obscures the headquarters buildings.

Studies now in progress are testing methods of reducing competition from grass and weeds and methods of controlling seed enemies so that natural seeding will have a better chance of producing new trees.

Artificial regeneration (planting of nursery-grown trees, or sowing seed directly) has been only partially successful. Basic requirements, developed at Fort Valley, include:

1. Use only local seed, or first-grade seedlings grown from local seed.

2. Plant only on sites where ponderosa pine has grown in the past.

3. Avoid areas of heavy competition from grass or weeds, or control the competition.

4. Protect seed from rodents and birds, and seedlings from browsing animals.

Further research will be needed to develop these general principles into successful techniques for reestablishing a forest on denuded areas.

Growing the Young Forest

As a young timber stand matures, its maximum value can be developed through special treatments. Recommendations developed from Fort Valley research should be applied to even-aged groups of trees as follows:

1. When the young stand is well established (most trees 6 feet or more tall), thin to 600 trees per acre (8-1/2 foot average spacing).

2. When the stand reaches pulpwood size (average tree 7 inches in diameter, 4-1/2 feet above the ground) thin to a reserve of 80 square-feet of basal area per acre. Basal area is the sum of cross-sectional areas of the tree trunks, measured at 4-1/2 feet above the ground.

3. Prune about 100 of the best reserve trees to the acre. Remove all limbs to a height of 18 feet, cutting each close to the trunk.

4. Re-thin the stand at about 20-year intervals, reserving 80 square-feet of basal area per acre at each operation, until the final stand is mature and ready for harvest.

5. Large worthless trees may be poisoned with either sodium arsenite or the safer ammonium sulfamate (Ammate).

This thinning regime was developed from very limited data. Further research is needed to refine and confirm the recommended actions.

Management Systems

In the development of forest management, the techniques of regenerating, growing, and finally harvesting the stands are integrated into a system of management. Several such systems have been tested at Fort Valley: group selection, light selection, scattered seed tree, favoring dominants, and salvage.

From a study of these systems, another was developed, which is now recommended for application in southwestern ponderosa pine. It is called "improvement selection." The objective is to place the stand in a vigorous growing condition and to build up an effective growing stock by improving spacing in all sawtimber-sized groups; retaining the best quality stems for future growth; and removing declining, poor-risk, diseased, defective, or poor-quality trees.

The improvement-selection principles are being applied to most managed forests in the Southwest. Marking rules for the first one or two cuts in virgin forests, and for the first re-cut in old cutover forests have been developed (figs. 4 and 5). The current Fort Valley research program includes the development of additional techniques for subsequent cutting, which will be needed to provide orderly harvest for currently mature trees and the conversion of the forests to balanced age groups.

It is possible that even-aged management may in the long run be more productive than selection management. The theory needs to be tested in future studies.

◁——Figure 4.--The Wing Mountain plot in 1939 just before its second logging. This plot has the distinction of being one of the first areas in the West from which two crops of timber have been harvested by the U. S. Forest Service. It was first logged in 1909.

Figure 5.--The same plot after the second logging. This group of trees will provide 4 more cuts at intervals of 20 to 30 years. By the time the last trees have been removed, some of the young growth in the background will be ready for harvest. ——▷

Growth and Development of Managed Stands

Management systems are evaluated in part by the growth and development of the stands left after cutting. At Fort Valley all trees 8 inches in diameter and larger have been tagged and remeasured at 5-year intervals on 11 large plots (72 to 320 acres each) that were cut under various systems, and on one virgin plot. Measurements will be continued indefinitely at 10-year intervals on 7 cutting plots and the virgin plot.

From the past measurements, equations for estimating growth and mortality following cutting have been derived.

Control of Damaging Agents

Several of the enemies of ponderosa pine can be controlled to some extent through special management practices. Among those studied at Fort Valley are:

1. Wind and lightning, which together account for about 70 percent of the mortality in both virgin and managed stands. Young thrifty trees are much more resistant than old overmature ones. Application of improvement selection greatly reduces the loss through cutting the most susceptible (poor-risk) trees.

2. Bark beetles of various species are third in causing mortality. Improvement selection again reduces losses by cutting poor-risk trees.

3. Dwarfmistletoe, the most serious disease (fig. 6), kills some trees, badly deforms others, and reduces growth of severely infected trees. Control through stand management is being studied currently with the aid of station pathologists.

4. Red rot destroys as much as 20 percent of the usable wood in virgin stands. Proper thinning and pruning can practically eliminate the loss in managed forests.

5. Limb rust is a slow but certain killer; fortunately it attacks only occasional trees. Cutting cycles of 20 years of less under the improvement-selection system make it possible to salvage most infected trees before they die.

Figure 6. --A female dwarfmistletoe plant growing on a ponderosa pine twig. This parasite is the most serious tree disease in the Southwest.

6. Livestock and deer kill or damage seedlings (fig. 7). The need to control domestic livestock is obvious. Deer-repellent chemicals are being studied at Fort Valley.

Most other enemies must be met by special control measures. The seriousness of many of these has been established and necessary research is being carried out elsewhere by other research groups.

Fire is the best known forest enemy. Prevention, including fuel-reduction measures, has been and is being studied by other Forest Service researchers. Guides to salvage fire-damaged forests have been developed.

Porcupines and seed-eating rodents are under study by the U. S. Fish and Wildlife Service.

The seriousness of certain other enemies is yet to be established. Current studies at Fort Valley will shed light on the damage done by Abert squirrels and cone beetles. Tip moths should also be studied.

Figure 7. --New buds formed on this ponderosa pine after a terminal shoot had been browsed off by deer.

SELECTED LIST OF PUBLICATIONS

Some 100 articles have been published covering the work at Fort Valley. By far the most important is:

Pearson, G. A.
1950. Management of ponderosa pine in the Southwest. U. S. Dept. Agr. Agr. Monog. 6, 218 pp., illus.

This bulletin reviews much of the work done at Fort Valley from 1908 through 1946. Earlier publications of historic importance, or that present results not covered in the monograph are:

Betts, H. S.
1912. Possibilities of western pines as a source of naval stores. U. S. Forest Serv. Bul. 116, 23 pp., illus.

Haasis, Ferdinand W.
1923. Frost heaving of western yellow pine seedlings. Ecol. 4: 378-390, illus.

Krauch, Hermann.
1926. The determination of increment in cut-over stands of western yellow pine in Arizona. Jour. Agr. Res. 32: 501-541, illus.

Lexen, B. R.
1935. Some factors influencing the yield and mortality of ponderosa pine in the Southwest. Jour. Agr. Res. 50: 777-787, illus.

Pearson, G. A.
1910. Reproduction of western yellow pine in the Southwest. U. S. Forest Serv. Cir. 174, 16 pp.

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1923. Natural reproduction of western yellow pine in the Southwest. U. S. Dept. Agr. Bul. 1105, 144 pp., illus.

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1924. Studies in transpiration of coniferous tree seedlings. Ecol. 5: 340-347, illus.

_____ 1931. Forest types in the Southwest as determined by climate and soil. U. S. Dept. Agr. Tech. Bul. 247, 144 pp., illus.

_____ 1940. Timber stand improvement in the Southwest. U. S. Fed. Security Agency, Civ. Conserv. Corps Forestry Pub. 6, 12 pp., illus.

_____ 1940. Reforestation in the Southwest by CCC camps. U. S. Fed. Security Agency, Civ. Conserv. Corps Forestry Pub. 7, 14 pp., illus.

_____ 1942. Herbaceous vegetation a factor in regeneration of ponderosa pine. Ecol. Monog. 12: 315-338, illus.

_____ 1942. Improvement selection cutting in ponderosa pine. Jour. Forestry 40: 753-760, illus.

_____ 1944. Applied genetics in forestry. Sci. Monthly 58: 444-453, illus.

_____ and McIntyre, Arthur C.
1935. Slash disposal in the ponderosa pine forests of the Southwest. U. S. Dept. Agr. Cir. 357, 29 pp., illus.

_____ and Marsh, R. E.
1935. Timber growing and logging practice in the Southwest and in the Black Hills region. U. S. Dept. Agr. Tech. Bul. 480, 80 pp., illus.

Most of the earlier references are out of print, but are available in major forestry libraries throughout the country.

Publications since Agriculture Monograph No. 6 include:

Gaines, Edward M., and Kotok, E. S.
1954. Thinning ponderosa pine in the Southwest. U. S. Forest Serv. Rocky Mountain Forest and Range Expt. Sta. Sta. Paper 17, 20 pp., illus. [Processed.]

Herman, F. R.
1954. A guide for marking fire-damaged ponderosa pine in the Southwest. U. S. Forest Serv. Rocky Mountain Forest and Range Expt. Sta. Res. Note 13, 4 pp. [Processed.]

———
1954. Use of Ammate crystals for poisoning ponderosa pine in stand improvement. U. S. Forest Serv. Rocky Mountain Forest and Range Expt. Sta. Res. Note 14, 5 pp. [Processed.]

Meagher, George.
1950. Reproduction of ponderosa pine. Jour. Forestry 48: 188-191.

Pearson, G. A.
1949. Management of cut-over land in the interior ponderosa pine type. Jour. Forestry 47: 172-178, illus.

———
1951. A comparison of the climate in four ponderosa pine regions. Jour. Forestry 49: 256-258, illus.

LOOKING FORWARD

The work at Fort Valley is not finished. True, many studies have been completed. Others are still in progress and new ones are being added as new vistas unfold.

Research, like the forest itself, is a growing thing. It looks to the future. It moves forward with the times. Or to paraphrase Tennyson:

"All research is an arch wherethrough gleams

that untraveled world, whose margins fade

forever and forever as we move."